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## Understanding self and others: From origins to disorders

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In order to interpret and engage with the social world, individuals must understand how they relate to others. Self-other understanding forms the backbone of social cognition, and is a central concept explored by research into basic processes such as action perception and empathy, as well as research on more sophisticated social behaviours such as cooperation and intergroup interaction. This theme issue integrates the latest research into self-other understanding from evolutionary biology, anthropology, psychology, neuroscience, and psychiatry. By gathering perspectives from a diverse range of disciplines, the contributions showcase ways in which research in these areas both informs, and is informed by, approaches spanning the biological and social sciences, thus deepening our understanding of how we relate to others in a social world.

### 1. Introduction

The past 20 years have brought extraordinary progress to our understanding of social cognition. Evolutionary biologists have uncovered sophisticated abilities in non-human primates such as perspective taking [1,2] and social learning [3,4]. Developmental psychologists and anthropologists have delineated both the universal origins, and culturally variable trajectories, of pro-social abilities and morality [5-7]. At the same time, our understanding of the mechanisms underlying social cognition has been both aided and challenged by the discovery of mirror neurons [8], a discovery which has simultaneously confirmed the importance of self-related processing in understanding others [9-11], and raised further questions about the phylogenetic and ontogenetic origins of such mechanisms [12]. In the clinical domain, a growing appreciation of the heterogeneity present in socio-cognitive disorders [e.g. 13] has led to an increased emphasis on understanding the mechanisms underlying deficits in specific socio-cognitive abilities, rather than considering clinical groups as presenting with homogeneous patterns of impairment [14-16].

Despite the considerable advances each of these individual disciplines has contributed to our understanding of human social cognition, few opportunities exist for researchers across these fields to consider how their work informs and is informed by related work in other disciplines. Core questions in human social cognition, such as how we use our own experience to understand the experience of others, and how we understand the ways in which we are connected to others, tap into a key construct that transcends disciplinary boundaries: namely, the understanding of the relationship between self and other. While the importance of characterizing the neurocognitive mechanisms and behavioural consequences of self-other understanding is clear, further progress in elucidating how self-other understanding contributes to social interaction, and in improving self-other understanding in socio-cognitive disorders, will require interdisciplinary integration. To address this urgent need, this theme

issue has been designed to facilitate the interdisciplinary exchange that is required to advance both basic science and the clinical applications of social cognition research.

This theme issue brings together researchers from a rich array of disciplines to discuss the latest developments in self-other understanding. The issue is organised into two broad thematic strands. The first addresses the origins of social cognition and the second addresses the processes supporting typical and atypical social cognition. The theme issue begins with papers highlighting the latest comparative research on the phylogenetic origins of cooperation, and anthropological research into cultural influences on self-other relationships. Next, papers examining the developmental origins of social cognition articulate how self-other differentiation develops, and how young children demonstrate sensitivity to self-other differentiation by dividing the world into social groups. The latter part of the issue focuses on mechanisms of social cognition. It includes empirical work exploring how training interventions aimed at improving self-other control processes can modulate empathy, and a study that investigates the underlying neural architectures that support effective understanding of other agents, whether human or artificial. The theme issue concludes with a number of contributions offering fresh insights and new theoretical proposals that address how the mechanisms underlying self-other understanding break down in disorders of social cognition including autism, depression, and schizophrenia.

In order to facilitate interdisciplinary integration and exchange between the distinct disciplines and themes that are covered in this issue, we have also asked researchers from three different backgrounds to compose commentary pieces that not only review their own work on these topics, but also relate it to the contributions from different disciplinary perspectives, discussing how work in their own field informs, or is informed by, work in other areas. Our aim is that these commentary pieces will help to break down traditional disciplinary barriers and so prompt progress that is not possible when each discipline operates in isolation.

The contributors to this theme issue are seeking novel answers to the overarching questions which define the field, including: What are the evolutionary and cultural origins of our social cognitive abilities? How do innate predispositions interact with the environment across development? What are the cognitive mechanisms underlying self-other understanding, and are they uniquely social or domain general in nature? How can we harness our knowledge of social cognition to understand atypical development and cognition? These questions are deeply interconnected and inherently interdisciplinary in nature. Building on these questions, the following sections highlight the main contributions made by each paper to this theme issue.

## **2. Origins: The Evolution and Development of Social Cognition**

The first area of investigation in this theme issue draws upon research placed at the interface between evolutionary biology, psychology and anthropology. Several papers address the origins of human social abilities, using a variety of complementary approaches to investigate how human biology interacts with cultural influences to produce variation in self-other understanding between social groups. Schmelz and Call [17] begin with an evolutionary approach, critically reviewing the experimental literature on how chimpanzees interact with each other through cooperation and competition. They highlight the need to study social cognitive skills, as well as social motivation, within the context of both cooperation and competition.

Heyes [18] focuses on the importance of learning and proposes that cultural practices may influence the development of social abilities. Taking the specific example of imitation, she deconstructs the widely-held belief among developmental and comparative psychologists that the superior imitation abilities of humans are due to a special, evolved ‘in-built’ matching mechanism [19] that endows us with the ability to match representations of self and other. She argues instead that the ability to imitate may be the result of cultural practices, and that the associative sequence learning model of imitation (ASL) provides an alternative account supported by empirical evidence. To further support this claim, she systematically addresses seven possible criticisms of the ASL model.

Keller too emphasises learning but takes a cross-cultural approach to the development of understanding self and other [20]. She discusses two key dimensions of social relationships into which children may be socialised: autonomy and relatedness. Taking the examples of middle class German children and the children of Nso farmers in North Western Cameroon, she describes how parenting practices may lead children to have a more autonomous or more relational understanding of their relationship to others.

The commentary by Nielsen and Haun [21] draws together the approaches mentioned here. It emphasises the importance of adopting a comparative and cross-cultural approach to understanding development in particular, and social cognition more generally. Nielsen and Haun review the literature on social learning, cooperation, prosociality and theory of mind using developmental, comparative and cross-cultural evidence. They highlight the importance of social motivation in explaining uniquely human forms of social cognitive abilities such as imitation and cooperation.

The next group of papers complement this evolutionary perspective by focusing more specifically on the development of self-other understanding across a variety of different processes, from empathy to group membership. Steinbeis [22] describes the neurodevelopmental underpinnings of the ability to distinguish between representations of the self and of others during social interaction. He sets out a contrast between the process of self-other distinction in cognitive and affective domains that is also discussed in later contributions [23,24]. Steinbeis' review describes how the ability to distinguish between self and other emerges in early childhood, and the development of this ability into adulthood.

Over's paper [25] picks up on the theme of motivation and explores the developmental origins of our need to belong. By marshalling evidence from developmental and social psychology, she crafts a compelling case for the importance of social motivation for understanding social behaviour. She concludes by arguing that, in order better to understand social cognition and behaviour in individuals of all ages, it will be imperative to develop a new programme of experimental research that systematically examines the role played by social motivation across development.

McAuliffe and Dunham [26] adopt an intergroup perspective on the relationship between self and other and discuss why children prefer members of their own group. They discuss evidence that both adults and children tend to share more resources with members of their own group and critically evaluate why this is. They conclude that, although the pattern of evidence is complex, the data are broadly consistent with an account based on general affective preferences.

The commentary by Milward and Sebanz [27] addresses how mechanisms underpinning self-other distinctions develop. The authors examine how the other contributions in this section might help us to understand more deeply the role played by empathy during social interaction. They offer insights into how we accomplish actions cooperatively with others, and set the stage for uniting the relatively independent literatures concerning dyadic and group-based interactions.

### **3. Processes: Mechanisms and Disorders of Social Cognition**

The second key theme of this issue relates to the processes underlying social cognition. The latter two sections of the special issue feature contributions that delve into the mechanisms and disorders of social cognition, thus shedding light on what is required for successful interactions with others in a social world.

Decety and colleagues [28] pick up on the theme of empathy and take an integrative approach to investigating the mechanisms underlying this key process for interacting with and understanding others. They review the evolutionary basis of empathy and describe how our improved understanding of the mechanisms underlying empathy can lead to treatments for disorders of social interaction.

Also focusing on empathy, de Guzman and colleagues [23] use an innovative training paradigm to test the hypothesis that bolstering self-other distinction should lead to increased empathy in a group of healthy young adults. In two independent experiments, the authors demonstrate that individuals who train to distinguish representations of self and other in the motor domain demonstrate increased empathic responses, as measured by corticospinal responses and self-reported

empathy. These findings highlight how an intervention in one sociocognitive domain can change responses in another, and hold great promise for using behavioural interventions to improve functioning across multiple social domains.

The empirical contribution by Cross and colleagues [29] investigates the effect of similarity between self and other on social perception, using artificial robotic agents in order to vary cues to human animacy. Cross et al. demonstrate that the neural mechanisms underlying social perception are sensitive to beliefs regarding whether an agent has human or artificial origins, rather than simply to cues indicating physical similarity. This suggests that interactions with others may be more strongly modulated by beliefs regarding self-other similarity, than by actual physical similarity.

The final group of papers in this theme issue focus on disorders of social cognition, and the extent to which these can be related to impairment of specific versus more general socio-cognitive mechanisms, reflecting a theme common to other contributions [e.g. 18]. Leekam [30] focuses on the neurodevelopmental condition that is probably the prototypical example of a breakdown in self-other understanding: autism spectrum disorder. She reviews the evidence for a 'primary' impairment in social cognition in autism, concluding that the data support a domain-general, rather than social-specific, account of the difficulties encountered by people with autism. She calls for a broadening of the research focus to encompass non-social as well as social difficulties in autism.

Hamilton [31] builds on previous work emphasizing the value of studying interactive social behaviour and social exchange to advance our understanding of social cognition. She focuses on the meaning and value of direct gaze cues, and how the processing of these cues differs in autism. In particular, Hamilton argues that direct gaze cues can act on a number of levels, from arousal and response modulation to self-engagement and reputation management, and highlights the importance of context effects when studying gaze in the laboratory. She concludes by articulating specific factors to be examined and controlled when testing the neurocognitive processes impacted by direct gaze cues, which might ultimately help researchers develop a theory of how a pair of eyes, whether encountered in a drawing, photograph, or a real person, can influence social cognition and behaviour in such a profound manner.

Schilbach, a practising clinical psychiatrist, brings first-hand experience to his review of the reciprocal relationship between psychiatric disorders and impaired social functioning [32]. He advances the position that a range of psychiatric disorders, including autism, personality disorders, depression, schizophrenia, substance use disorders and social anxiety disorders, can be characterized as disorders of social interaction. He concludes with a systematic discussion of how refocusing research attention on the dynamics of social interaction in these disorders could provide fresh insights for social neuroscience as a discipline.

The theme issue concludes with a commentary by Lamm and colleagues [24] that relates not only to socio-cognitive disorders but also to contributions on the origins and development of self-other understanding in relation to empathy. The authors address how a breakdown in different components of the empathetic response – i.e. in either shared emotional representations between self and other or in the ability to distinguish between representations of self and other – is involved in disorders of social cognition.

#### **4. Conclusion**

In this theme issue, our aim was to integrate research across a range of disciplines, investigating the phylogenetic and ontogenetic origins of self-other understanding, the psychological and neuroscientific mechanisms underlying how other-related information is processed with respect to that relating to the self, and the consequences of atypicalities in either the origins or mechanisms for social functioning. By exploring how research in each discipline depends on and is informed by advances in other fields, we hope this theme issue will facilitate the formulation of new questions and the generation of new insights into social cognition that transcend typical disciplinary boundaries.

# Additional Information

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## Authors' Contributions

CC, ESC and HO wrote the manuscript.

## Competing Interests

We have no competing interests.

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